

What is claimed is:

1. A method of making a high softening point coal tar pitch using high efficiency evaporative distillation, comprising the steps of:

5 feeding a feed coal tar pitch having a softening point in the range of 70°C to 160°C into a processing vessel wherein said processing vessel is heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel is 5 Torr or less; and

10 withdrawing an output coal tar pitch from said processing vessel, said output coal tar pitch having a softening point in the range of 140°C to 300°C and having less than 5% mesophase content.

15 2. A method according to claim 1, said output coal tar pitch having a softening point in the range of 150°C to 250°C.

3. A method according to claim 1, said output coal tar pitch having less than 1% mesophase content.

20 4. A method according to claim 1, said feed coal tar pitch having a softening point in the range of 110°C to 140°C.

5. A method according to claim 1, wherein said processing vessel is heated to a temperature in the range of 350°C to 500°C.

6. A method according to claim 1, wherein said output coal tar pitch has a B(a)P

5 Equivalent less than or equal to 500 ppm.

7. A method according to claim 1, said feeding step comprising introducing said feed coal tar pitch into a wiped film evaporator, said wiped film evaporator comprising said processing vessel.

8. A method according to claim 7, wherein a feed rate of said feed coal tar pitch into said wiped film evaporator is in the range of 10 to 100 pounds/square foot of surface area/hour.

9. A method according to claim 7, wherein a feed rate of said feed coal tar pitch into said wiped film evaporator is in the range of 35 to 50 pounds/square foot of surface area/hour.

10. A method according to claim 8, wherein a residence time of said feed coal tar pitch in said processing vessel is in the range of 1 to 60 seconds.

11. A method according to claim 9, wherein a residence time of said feed coal tar pitch in said processing vessel is in the range of 5 to 30 seconds.

12. A method according to claim 7, wherein said wiped film evaporator forms a film of said feed coal tar pitch on an interior wall of said processing vessel, said film having a minimum thickness of 1 millimeter.

5 13. A method according to claim 1, said feeding step comprising introducing said feed coal tar pitch into a thin film evaporator, said thin film evaporator comprising said processing vessel.

10 14. A method according to claim 13, wherein a feed rate of said feed coal tar pitch into said thin film evaporator is in the range of 10 to 100 pounds/square foot of surface area/hour.

15 15. A method according to claim 13, wherein a feed rate of said feed coal tar pitch into said thin film evaporator is in the range of 35 to 50 pounds/square foot of surface area/hour.

16. A method according to claim 14, wherein a residence time of said feed coal tar pitch in said processing vessel is in the range of 1 to 60 seconds.

20 17. A method according to claim 15, wherein a residence time of said feed coal tar pitch in said processing vessel is in the range of 5 to 30 seconds.

18. A method according to claim 13, wherein said thin film evaporator forms a film of said feed coal tar pitch on an interior wall of said processing vessel, said feed coal tar pitch comprising a plurality of QI particles, said film having a minimum thickness that is no smaller than a thickness of a largest one of said QI particles.

5

19. A method according to claim 1, said feeding step comprising introducing said feed coal tar pitch into a conventional distillation apparatus, said conventional distillation apparatus comprising said processing vessel, said output coal tar pitch having a softening point in the range of 140° to 180°C.

20. A method of making a pitch using high efficiency evaporative distillation, comprising the steps of:

feeding a feed coal tar pitch having a softening point in the range of 70°C to 160°C into a processing vessel, wherein said processing vessel is heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel is 5 Torr or less;

withdrawing an output coal tar pitch from said processing vessel, said output coal tar pitch having a softening point in the range of 140°C to 300°C and having less than 5% mesophase content; and

combining said output coal tar pitch with a plasticizer.

21. A method according to claim 20, wherein said plasticizer comprises a coal tar having a viscosity in the range of 2 to 5 centistokes at 210°F and a B(a)P equivalent of no more than 500 ppm B(a)P.

5 22. A method according to claim 21, wherein said plasticizer comprises a mixture of said coal tar and a petroleum oil, said petroleum oil constituting 30% to 60% of said mixture.

23. A method according to claim 20, said feeding step comprising introducing said coal tar pitch into a wiped film evaporator, said wiped film evaporator comprising said processing vessel.

24. A method according to claim 20, said feeding step comprising introducing said coal tar pitch into a thin film evaporator, said thin film evaporator comprising said processing vessel.

25. A method according to claim 20, said feeding step comprising introducing said feed coal tar pitch into a conventional distillation apparatus, said conventional distillation apparatus comprising said processing vessel, said output feed coal tar pitch having a softening point in the range of 140°C to 180°C.

26. A method according to claim 20, said output coal tar pitch having a softening

point in the range of 150°C to 250°C.

27. A method according to claim 20, said feed coal tar pitch having a softening point in the range of 110°C to 140°C.

5

28. A method according to claim 20, wherein said processing vessel is heated to a temperature in the range of 350°C and 500°C.

29. A method of making a quinoline insoluble-free and ash-free coal tar pitch having a desired softening point, comprising the steps of:

feeding a feed coal tar pitch having an initial softening point in the range of 70°C to 160°C into a processing vessel, wherein said processing vessel is heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel is 5 Torr or less;

obtaining a distillate from said processing vessel, said distillate having a softening point in the range of 25°C to 60°C and being quinoline insoluble-free and ash-free;

heat treating said distillate at a temperature in the range of 350°C to 595°C for between five minutes and forty hours; and

distilling the heat treated distillate to obtain a pitch having the desired

20 softening point.

30. A method according to claim 29, said feeding step comprising introducing said feed coal tar pitch into a wiped film evaporator, said wiped film evaporator comprising said processing vessel.

5 31. A method according to claim 29, said feeding step comprising introducing said feed coal tar pitch into a thin film evaporator, said thin film evaporator comprising said processing vessel.

10 32. A method according to claim 29, said feeding step comprising introducing said feed coal tar pitch into a conventional distillation apparatus, said conventional distillation apparatus comprising said processing vessel.

15 33. A method according to claim 29, wherein said heat treated distillate has a softening point in the range of 60°C to 110°C.

20 34. A method of making a mesophase coal tar pitch, comprising of the steps of:
feeding a feed coal tar pitch having a softening point in the range of 70°C to 160°C into a processing vessel, wherein said processing vessel is heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel is 5 Torr or less;

obtaining a distillate from said processing vessel, said distillate having a softening point in the range of 25°C to 60°C and being quinoline insoluble-free and ash-free; and

heat treating said distillate at a temperature in the range of 370°C to 595°C
for between three and forty hours.

35. A method according to claim 34, said feeding step comprising introducing said
5 feed coal tar pitch into a wiped film evaporator, said wiped film evaporator comprising said
processing vessel.

36. A method according to claim 34, said feeding step comprising introducing said
10 feed coal tar pitch into a thin film evaporator, said thin film evaporator comprising said
processing vessel.

37. A method according to claim 34, said feeding step comprising introducing said
15 feed coal tar pitch into a conventional distillation apparatus, said conventional distillation
apparatus comprising said processing vessel.

38. A method of making a quinoline insoluble-free and ash-free coal tar pitch,
comprising of the steps of:
feeding a feed coal tar pitch having a softening point in the range of 70°C
to 160°C into a first processing vessel, wherein said first processing vessel is heated to a
20 temperature in the range of 300°C to 600°C and wherein a pressure inside said first processing
vessel is 5 Torr or less;

obtaining a distillate from said first processing vessel, said distillate having a softening point in the range of 25°C to 60°C and being quinoline insoluble-free and ash-free;

5 heat treating said distillate at a temperature in the range of 350°C to 595°C for between five minutes and forty hours;

distilling the heat treated distillate to obtain a pitch having a desired softening point;

feeding said pitch having a desired softening point into a second processing vessel, wherein said second processing vessel is heated to a temperature in the range of 300°C to 600°C; and

withdrawing an output coal tar pitch from said second processing vessel.

39. A method according to claim 38, wherein said first processing vessel and said second processing vessel are the same vessel.

40. A method according to claim 39, wherein said first and second processing vessel is a wiped film evaporator.

41. A method according to claim 38, wherein said first processing vessel comprises a
20 wiped film evaporator.

42. A method according to claim 38, wherein said second processing vessel comprises a wiped film evaporator.

43. A method according to claim 39, wherein said first and second processing vessel
5 is a thin film evaporator.

44. A method according to claim 38, wherein said first processing vessel comprises a thin film evaporator.

10 45. A method according to claim 38, wherein said second processing vessel comprises a thin film evaporator.

46. A method according to claim 39, wherein said first and second processing vessel are comprised of a conventional distillation apparatus.

15 47. A method according to claim 38, wherein said first processing vessel further comprises a conventional distillation apparatus.

48. A method according to claim 38, wherein said second processing vessel further
20 comprises a conventional distillation apparatus.

49. A method of making a high softening point hydrocarbon mixture pitch using high efficiency evaporative distillation, comprising the steps of:

feeding a feed hydrocarbon mixture pitch having a softening point in the range of 70°C to 160°C into a processing vessel wherein said processing vessel is heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel is 5 Torr or less; and

withdrawing an output hydrocarbon mixture pitch from said processing vessel, said output hydrocarbon mixture pitch having a softening point in the range of 140°C to 300°C and having less than 5% mesophase content.

50. A method according to claim 49, said output hydrocarbon mixture pitch having a softening point in the range of 150°C to 250°C.

51. A method according to claim 49, said output hydrocarbon mixture pitch having less than 1% mesophase content.

52. A method according to claim 49, said feed hydrocarbon mixture pitch having a softening point in the range of 110°C to 140°C.

53. A method according to claim 49, wherein said processing vessel is heated to a temperature in the range of 350°C to 500°C.

54. A method according to claim 49, wherein said output hydrocarbon mixture pitch has a B(a)P Equivalent less than or equal to 500 ppm.

55. A method according to claim 49, said feeding step comprising introducing said
5 feed hydrocarbon mixture pitch into a wiped film evaporator, said wiped film evaporator comprising said processing vessel.

56. A method according to claim 55, wherein a feed rate of said feed hydrocarbon
mixture pitch into said wiped film evaporator is in the range of 10 to 100 pounds/square foot of
10 surface area/hour.

57. A method according to claim 55, wherein a feed rate of said feed hydrocarbon
mixture pitch into said wiped film evaporator is in the range of 35 to 50 pounds/square foot of
15 surface area/hour.

58. A method according to claim 56, wherein a residence time of said feed
hydrocarbon mixture pitch in said processing vessel is in the range of 1 to 60 seconds.

59. A method according to claim 57, wherein a residence time of said feed
20 hydrocarbon mixture pitch in said processing vessel is in the range of 5 to 30 seconds.

60. A method according to claim 55, wherein said wiped film evaporator forms a film of said feed hydrocarbon mixture pitch on an interior wall of said processing vessel, said film having a minimum thickness of 1 millimeter.

5 61. A method according to claim 49, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a thin film evaporator, said thin film evaporator comprising said processing vessel.

10 62. A method according to claim 61, wherein a feed rate of said feed hydrocarbon mixture pitch into said thin film evaporator is in the range of 10 to 100 pounds/square foot of surface area/hour.

15 63. A method according to claim 61, wherein a feed rate of said feed hydrocarbon mixture pitch into said thin film evaporator is in the range of 35 to 50 pounds/square foot of surface area/hour.

64. A method according to claim 62, wherein a residence time of said feed hydrocarbon mixture pitch in said processing vessel is in the range of 1 to 60 seconds.

20 65. A method according to claim 63, wherein a residence time of said feed hydrocarbon mixture pitch in said processing vessel is in the range of 5 to 30 seconds.

66. A method according to claim 61, wherein said thin film evaporator forms a film of said feed hydrocarbon mixture pitch on an interior wall of said processing vessel, said feed hydrocarbon mixture pitch comprising a plurality of QI particles, said film having a minimum thickness that is no smaller than a thickness of a largest one of said QI particles.

5

67. A method according to claim 49, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a conventional distillation apparatus, said conventional distillation apparatus comprising said processing vessel.

68. A method according to claim 49, said feed hydrocarbon mixture pitch comprising a mixture of coal tar pitch and petroleum pitch.

69. A method according to claim 68, said feed hydrocarbon mixture pitch comprising at least 50% coal tar pitch.

70. A method of making a pitch using high efficiency evaporative distillation, comprising the steps of:

feeding a feed hydrocarbon mixture pitch having a softening point in the range of 70°C to 160°C into a processing vessel, wherein said processing vessel is heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel is 5 Torr or less;

withdrawing an output hydrocarbon mixture pitch from said processing vessel, said output hydrocarbon mixture pitch having a softening point in the range of 140°C to 300°C and having less than 5% mesophase content; and

combining said output hydrocarbon mixture pitch with a plasticizer.

5

71. A method according to claim 70, wherein said plasticizer comprises a coal tar having a viscosity in the range of 2 to 5 centistokes at 210°F and a B(a)P equivalent of no more than 500 ppm B(a)P.

72. A method according to claim 71, wherein said plasticizer comprises a mixture of said coal tar and a petroleum oil, said petroleum oil constituting 30% to 60% of said mixture.

73. A method according to claim 70, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a wiped film evaporator, said wiped film evaporator comprising said processing vessel.

74. A method according to claim 70, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a thin film evaporator, said thin film evaporator comprising said processing vessel.

75. A method according to claim 70, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a conventional distillation apparatus, said conventional

distillation apparatus comprising said processing vessel.

76. A method according to claim 70, said output hydrocarbon mixture pitch having a softening point in the range of 150°C to 250°C.

5

77. A method according to claim 70, said feed hydrocarbon mixture pitch having a softening point in the range of 110°C to 140°C.

78. A method according to claim 70, wherein said processing vessel is heated to a temperature in the range of 350°C and 500°C.

79. A method according to claim 70, said feed hydrocarbon mixture pitch comprising a mixture of coal tar pitch and petroleum pitch.

80. A method according to claim 79, said feed hydrocarbon mixture pitch comprising at least 50% coal tar pitch.

81. A method of making a quinoline insoluble-free and ash-free hydrocarbon mixture pitch having a desired softening point, comprising the steps of:

feeding a feed hydrocarbon mixture pitch having an initial softening point in the range of 70°C to 160°C into a processing vessel, wherein said processing vessel is heated

to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel is 5 Torr or less;

obtaining a distillate from said processing vessel, said distillate having a softening point in the range of 25°C to 60°C and being quinoline insoluble-free and ash-free;

5 heat treating said distillate at a temperature in the range of 350°C to 595°C for between five minutes and forty hours; and

distilling the heat treated distillate to obtain a pitch having the desired softening point.

10 82. A method according to claim 81, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a wiped film evaporator, said wiped film evaporator comprising said processing vessel.

15 83. A method according to claim 81, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a thin film evaporator, said thin film evaporator comprising said processing vessel.

20 84. A method according to claim 81, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a conventional distillation apparatus, said conventional distillation apparatus comprising said processing vessel.

85. A method according to claim 81, wherein said heat treated distillate has a softening point in the range of 60°C to 110°C.

86. A method according to claim 81, said feed hydrocarbon mixture pitch comprising
5 a mixture of coal tar pitch and petroleum pitch.

87. A method according to claim 86, said feed hydrocarbon mixture pitch comprising at least 50% coal tar pitch.

10 88. A method of making a mesophase hydrocarbon mixture pitch, comprising of the steps of:

feeding a feed hydrocarbon mixture pitch having a softening point in the range of 70°C to 160°C into a processing vessel, wherein said processing vessel is heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said processing vessel
15 is 5 Torr or less;

obtaining a distillate from said processing vessel, said distillate having a softening point in the range of 25°C to 60°C and being quinoline insoluble-free and ash-free; and

heat treating said distillate at a temperature in the range of 370°C to 595°C for between three and forty hours.

89. A method according to claim 88, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a wiped film evaporator, said wiped film evaporator comprising said processing vessel.

5 90. A method according to claim 88, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a thin film evaporator, said thin film evaporator comprising said processing vessel.

10 91. A method according to claim 88, said feeding step comprising introducing said feed hydrocarbon mixture pitch into a conventional distillation apparatus, said conventional distillation apparatus comprising said processing vessel.

15 92. A method according to claim 88, said feed hydrocarbon mixture pitch comprising a mixture of coal tar pitch and petroleum pitch.

93. A method according to claim 92, said feed hydrocarbon mixture pitch comprising at least 50% coal tar pitch.

20 94. A method of making a quinoline insoluble-free and ash-free hydrocarbon mixture pitch, comprising of the steps of:

feeding a feed hydrocarbon mixture pitch having a softening point in the range of 70°C to 160°C into a first processing vessel, wherein said first processing vessel is

heated to a temperature in the range of 300°C to 600°C and wherein a pressure inside said first processing vessel is 5 Torr or less;

obtaining a distillate from said first processing vessel, said distillate having a softening point in the range of 25°C to 60°C and being quinoline insoluble-free and ash-free;

heat treating said distillate at a temperature in the range of 350°C to 595°C for between five minutes and forty hours;

distilling the heat treated distillate to obtain a pitch having a desired softening point;

feeding said pitch having a desired softening point into a second processing vessel, wherein said second processing vessel is heated to a temperature in the range of 300°C to 600°C; and

withdrawing an output hydrocarbon mixture pitch from said second processing vessel.

95. A method according to claim 94, wherein said first processing vessel and said second processing vessel are the same vessel.

96. A method according to claim 95, wherein said first and second processing vessel is a wiped film evaporator.

97. A method according to claim 94, wherein said first processing vessel comprises a wiped film evaporator.

98. A method according to claim 94, wherein said second processing vessel
5 comprises a wiped film evaporator.

99. A method according to claim 95, wherein said first and second processing vessel is a thin film evaporator.

100. A method according to claim 94, wherein said first processing vessel comprises a
10 thin film evaporator.

101. A method according to claim 94, wherein said second processing vessel
comprises a thin film evaporator.

102. A method according to claim 95, wherein said first and second processing vessel
15 are comprised of a conventional distillation apparatus.

103. A method according to claim 94, wherein said first processing vessel further
20 comprises a conventional distillation apparatus.

104. A method according to claim 94, wherein said second processing vessel further comprises a conventional distillation apparatus.

105. A method according to claim 94, said feed hydrocarbon mixture pitch comprising
5 a mixture of coal tar pitch and petroleum pitch.

106. A method according to claim 105, said feed hydrocarbon mixture pitch comprising at least 50% coal tar pitch.